

SEMESTER WISE COURSE STRUCTURE

&

DETAILED SYLLABUS

M. TECH. CHEMICAL TECHNOLOGY-FOOD TECHNOLOGY

(Applicable from Session 2023-2024 for new entrants)



HARCOURT BUTLER TECHNICAL UNIVERSITY

KANPUR-208002 (UP) – INDIA

**HARCOURT BUTLER TECHNICAL UNIVERSITY
SCHOOL OF CHEMICAL TECHNOLOGY
DEPARTMENT OF FOOD TECHNOLOGY**

VISION OF THE UNIVERSITY

“To achieve excellence in technical education, research and innovation”

MISSION OF THE UNIVERSITY

1. *Imparting Knowledge to develop analytical ability in science and technology to serve the industry and society at large.*
2. *Equip and enable students with conceptual, technical and managerial skills to transform the organization and society.*
3. *Inculcating entrepreneurial philosophy and innovative thinking to promote research, consultancy and institutional social responsibility.*
4. *Serving people, society and nation with utmost professionalism, values and ethics to make development sustainable and quality of life.*

VISION OF THE DEPARTMENT

“To develop technically sound food technocrats, to cater the needs of food processing industries, Research & Development organizations and society”

MISSION OF THE DEPARTMENT

The missions of the Department of Food Technology are:

- M1 : Imparting technical knowledge to develop human resources for food processing sectors.*
- M2 : Imparting knowledge & technical skills for better processing and value addition of Food & Agro-products through R&D.*
- M3 : Inculcating innovative thinking with the aim to support entrepreneurship and to develop state-of-art technologies for testing and consultancy to fulfill the needs of industry and society.*
- M4 : Cultivating strong ethical values for sustainable modern and safe food to society.*

M. Tech. Chemical Technology - Food Technology
(Applicable from Session 2023-2024 for new entrants)

Year I, Semester-I

("A" Stream Only for students having B.Tech. in Food Technology background)

("B" Stream Only for students having B.Tech. in other than Food Technology background)

("C" Stream Only for students of M.Sc. (Chemistry/Applied Chemistry /Industrial Chemistry etc.,) background)

S. No.	Course Type	Course Code	Subject	Periods			Credits	Sessional marks			ESM	Total		
				L	T	P		MSE	TA	Lab			Total	
1	PCC	NCH- 509	Advanced Mathematical Methods in Chemical Engineering ^A	3	1	0	4	30	20	-	50	50	100	
2	PCC	NFT -501	Advances in Food Technology-I ^{ABC}	3	0	2	4	15	20	15	50	50	100	
3	PCC	NFT-503	Engineering Properties of Foods ^{ABC}	3	1	0	4	30	20	-	50	50	100	
4	PCC	NFT-505	Microbiology and Chemistry of Foods ^{BC}	3	1	0	4	30	20	-	50	50	100	
5	PEC	Programme Elective NFT-507	Post-harvest/Pre processing Quantified Operations ^A											
		NFT-509	Food Industry Waste Management ^A	3	1	0	4	30	20	-	50	50	100	
		NFT-511	Processing & Preservation of Foods ^{BC}											
		NMA-501	*Engineering Mathematics ^{BC}											
			Total	12	3	2	16							

* Only for students of Non Mathematics background at Graduation level.

Semester-wise Course Structure
M. Tech. Chemical Technology –Food technology

(Applicable from Session 2023-2024 for new entrants)

Year I, Semester-II

S. No.	Course Type	Course Code	Subject	Periods			Credits	Sessional marks			ESM	
				L	T	P		MSE	TA	Lab		Total
1	PCC	NFT-502	Advances in Food Technology-II	3	0	2	4	15	20	15	50	50
2	PCC	NFT-504	Food Process Engineering	3	1	0	4	30	20	-	50	50
3	PCC	NFT-506	Food Safety & Quality Assurance	3	1	0	4	30	20	-	50	50
4	PEC	NFT-508	Nutraceutical & Functional Foods	3	1	0	4	30	20	-	50	50
		NFT-510	Cryogenic Systems in food processing	3	1	0	4	30	20	-	50	50
		NFT-512	Advances in Food Packaging Technologies	3	1	0	4	30	20	-	50	50
			Total	12	3	2	16				200	200

Semester-wise Course Structure
M. Tech. Chemical Technology –Food technology

(Applicable from Session 2024-2025 for new entrants)
Year II, Semester-III

S. No.	Course Type	Course Code	Subject	Periods			Credits	Sessional marks			ESM	
				L	T	P		MSE	TA	Lab		Total
1	PEC	NFT-601	Frozen Food & Cold Chain Management	3	1	0	4	30	20	-	50	50
		NFT-603	Novel Techniques in Food Processing & Preservation	3	1	0	4	30	20	-	50	50
		NFT-605	Computer Applications in Food Processing	3	1	0	4	30	20	-	50	50
2	OEC	OFT-601	Advances in Food Processing and Preservation	3	0	0	3	30	20	-	50	50
3	Seminar	NFT-607	Seminar	0	0	2	1	-	50	-	50	50
4	Dissertation	NFT-609	Dissertation*	0	0	16	8	-	50	-	50	50
			Total	6	1	18	16				200	200

* to be continued in fourth semester

M. Tech. Chemical Technology –Food Technology
(Applicable from Session 2024-2025 for new entrants)
Year II, Semester-IV

S. No.	Course Type	Course Code	Subject	Periods			Credits	Sessional marks			ESM	
				L	T	P		MSE	TA	Lab		Total
1	Dissertation	NFT-602	Dissertation	0	0	32	16	-	50	-	50	50
			Total	0	0	32	16				50	50

NFT 501: ADVANCES IN FOOD TECHNOLOGY- I

L	T	P	C
3	0	2	4

Course Objective: The objective of the course is to impart

- Knowledge of food constituents and its related chemistry
- Knowledge of advance milling, baking technology and extrusion
- Knowledge recent advance in advance processing of oilseed, fruits and vegetables and spices

Course outcomes: On the successful completion of the course the student will be able to

CO1	Discuss the food constituent and their physico-chemical changes during storage and processing	Understanding
CO2	Understand advance milling technology and its advantage over conventional milling	Understanding
CO3	Discuss bakery technology and aware about recent development	Analyzing
CO4	Explain extrusion technology and first, second & third generation extruded products	Analyzing
CO5	Discuss the oilseed processing, refining and recent advances in oil modification	Applying
CO6	Understand about the advancement in fruits, vegetable and spices processing	Understanding

Syllabus

Module-I: Advances in food chemistry & biotechnology

Desirable and undesirable food constituents, Analytical approach to food chemistry, chemical/biochemical reactions and physical changes occurring during transportation storage & processing in foods and their implications on quality, permitted food additives and their rationale. Application of enzymes in food processing

Module-II: Milling of cereals & pulses and bakery products

Recent trends in milling operations for cereals and pulses, various types of improved machinery employed in rice and other grain milling, advances in baking technology, recent development in bakery ingredient and their functionality.

Module -III: Extrusion and extruded products

Principle of extrusion, advances in extrusion and co-extrusion processes, advances in extruded and other ready to eat food products e.g. Roasted toasted and fried products, instant ready to use formulations,

Module-IV: Processing of oilseeds

Advances in Processing of oilseeds for oil and protein products, advances in oil processing, recent modification in oil,

Module-V: Processing of fruits, vegetables and spices

Recent trends in fruits and vegetables preservation and processing techniques, high pressure processing. Advances in plantation products e.g. Tea, coffee and cocoa, Spices storage and their processing.

Module –VI: Experiments

1. Measurement of the browning index of cut potato slices by using CIE L*a*b* method.
2. Determination of the copper content in tea by Atomic Absorption Spectroscopy (AAS).
3. Extraction of lycopene from tomato and determination of its concentration.
4. Determination of the glass transition temperature of starch by DSC.
5. Coating of the guava by using aloe vera and compare the quality of coated and non-coated samples
6. Estimation of the Starch Pasting Profiles by Rapid Visco Analyser (RVA).
7. Extraction and determination of cholesterol in cow by High-Performance Liquid Chromatography (HPLC) method
8. Preservation of Fruits and Vegetables by Osmotic Dehydration Process

9. Study of the rheological property of stirred yoghurt
10. Study of the application of 3D in food processing

Reference Books and Suggested Readings:

Title

The Chemistry and Technology of Cereals as Food and Feed

Cereals Current Status and Vision

Author

Matz, S.A

TIFAC (DST) Report,

Spice Science and Technology

Hirasa, K & Takemasa, M

Quality Assurance in Spices and Spice Products
(Modern methods of analysis)

Pruthi, S

NFT-503: ENGINEERING PROPERTIES OF FOOD

L	T	P	C
3	1	0	4

Course objectives: The objective of this course is to impart

- Knowledge of physical, mechanical, thermal and other important engineering properties of foods
- Knowledge of application of engineering properties in designing of food engineering processes and equipment

Course Outcomes: On the successful completion of the course, students will be able to:

CO1	Understand the importance of physical properties in problem solving of food engineering operations	Understanding
CO2	Understand the textural properties of foods by experimental and mathematical models	Understanding
CO3	Estimation of thermal, hydrodynamics and aerodynamics properties of various foods	Applying
CO4	Understand the optical and dielectric properties of food products	Understanding
CO5	Understand and apply the concept of water activity, colligative properties and sorption isotherms of foods	Applying

Syllabus

Module-I: Physical properties of Foods

Mass-Volume-Area-Related Properties: size, shape, roundness, sphericity, geometric mean diameter, surface area, projected surface area, resemblance to geometric bodies, volume, bulk density, true density, specific gravity, porosity and their measurement. Particle Size Distribution, Acoustic properties of foods.

Module-II: Rheological Properties of Foods

Stress, strain, elastic limit, modulus of elasticity, poisson's ratio, shear strength, compressive strength, tensile strength, yield point, yield strength, deformation, bio yield point, rupture point, stiffness, elasticity, plasticity, degree of plasticity, toughness, resilience, mechanical hysteresis, viscoelasticity, stress relaxation, relaxation time, creep, retardation time, Mechanical models, Newton's Law of Viscosity; Newtonian Fluids; Non-Newtonian Fluids; ideal and non-ideal

Plastic Fluids; ideal and non-ideal viscous Fluids; ideal and non-ideal solids, Viscometry, Texture profile analysis, Dough Testing Instruments

Module-III: Thermal, Hydrodynamics and aerodynamic Properties of Foods

Thermal conductivity, Heat capacity, specific heat, thermal diffusivity, methods of determination – steady state and transient heat flow. **Hydrodynamics and aerodynamics properties of foods:** Terminal velocity, drag coefficient, Reynold's number, application of aerodynamic properties to food products.

Module-IV: Electromagnetic Properties of Foods

Colour, reflectance, diffraction, absorption, radiation, lightness, hue, chroma, saturation, value, gloss, tristimulus values of colour, CIE and Lab colour system, application of optical properties in food processing. **Dielectric properties:** dielectric constant, dielectric loss, power factor, dielectric heating, dielectric loss tangent, application of dielectric properties in food processing.

Module-V: Sorption & Surface Properties of Foods

Criteria of equilibrium, Raoult's and Henry's Law, colligative properties, water activity, effect of temperature on water activity, sorption isotherms, Hysteresis, Empirical equations such as GAB, BET, Peleg models etc. Surface tension, Laplace, Kelvin, Young & Dupre equation, colloidal systems of foods.

Reference Books and Suggested Readings:

Title	Author
Engineering Properties of Foods	M. A. Rao and others
Physical Properties of Foods	Sahin S. and Sumnu
Physical Properties of Plant and Animal Materials	N.N. Mohesnin
Physical Properties of Agricultural Materials and Food Products	R. Stroshine
Elements of Properties of Matter	D.S. Mathur

NFT 505: MICROBIOLOGY & CHEMISTRY OF FOODS

L	T	P	C
3	1	0	4

Course objectives: The objectives of this course are to impart:

- Knowledge on innate properties of food molecules and their interactions with other food constituents.
- Knowledge about identification and enumeration techniques of microbes found in food products.

Course outcomes: On the successful completion of the course the students will be able to:

CO1	Understand the chemistry of water and interaction of water with other food components	Understanding
CO2	Understand the chemistry and properties of carbohydrate & proteins and application of modified carbohydrates & proteins in food processing	Applying
CO3	Understand the basic structure of lipid and apply the knowledge of stabilizers & emulsifiers in food industry	Applying
CO4	Analyze the cause of spoilage of food by microorganisms and their controls	Analyzing
CO5	Discuss about food pathogens and application of antimicrobial chemicals in food industry	Analyzing

Syllabus

Module-I: Water Relations in Food

Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymatic, physical and microbial changes) and sorption isotherm, Glass transitions and molecular mobility in foods, their relevance to quality and shelf life of food systems, anticaking agents: Definition, role in preventing spoilage, mode of action, permitted list of anti-caking agents and food application.

Module-II: Carbohydrates and Proteins

Carbohydrates: Structure, classification and chemistry of carbohydrates, Starch, Hydrocolloids and gums: Occurrence, functions and properties, Modified starches.

Protein: Chemistry, structure and functions of amino acids and proteins, Role of enzyme in food processing, Functional properties of proteins: modified proteins, application in product formulation.

Module-III: Food Lipids

Chemistry of oils and fats, Antioxidants: Chemistry and mechanisms of action, Techniques of evaluation of antioxidant activity, Uses. Emulsifiers: Role of emulsifiers, different classes of emulsifiers and their chemical structure, Selection of emulsifier based on Hydrophilic and lipophilic balance (HLB) and its application, Role of different stabilizers and other substances in emulsion stability.

Module-IV: Food Spoilage

Cause of spoilage, Biochemical changes caused by microorganisms, Types of microorganism associated with food spoilage and their controls.

Module-V: Food Pathogens

Contamination of food, Sources of contamination, Food poisoning and microbial toxins, Use of antimicrobial chemicals: Organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbets/propionates naturally occurring antimicrobials-their mode of action.

Reference Books and Suggested Readings:

Title	Author
Food Chemistry	H.K Chopra and P.S. Panesar
Food Chemistry	S. Damodaran, K.L. Parkin and O.R. Fennema
Food Chemistry	H.D. Belitz, W. Grosch and P. Schieberle
Physical Chemistry of Foods	P. Walstra
Food Microbiology	M.R. Adams
Food Microbiology	Frazier, M.C William and C.W. Dennis
Food Microbiology	R.K. Vijaya

NFT-507: POST HARVEST/PRE PROCESSING QUANTIFIED OPERATIONS

L	T	P	C
3	1	0	4

Course objectives: The objectives of this course are to impart

- Knowledge on physicochemical properties, post harvesting/ Pre Processing techniques for fruits & vegetables and food grains.
- Knowledge about handling, processing preservation and storage of fruits & vegetables and food grains.
- Knowledge of different operations involved in minimal processing of fruits & vegetables and food grains.

Course outcomes: On the successful completion of the course the students will be able to:

CO1	Understanding of production, classification, structure and composition of fruits and vegetables and their quality measurement on basis of advance non-destructive methods	Understanding
CO2	Understanding of physicochemical properties of fruits and vegetables and their primary processing of operation	Understanding
CO3	Understand and apply different harvesting tools and Post-Harvest handling operations in processing of fruits and vegetables	Applying
CO4	Understand the Post-Harvest Diseases and role of engineering in packaging for delay in ripening/product quality maintenance	Understanding
CO5	Understand and apply the concept of drying of food grains and role of engineering in storage design of food grains	Applying

Syllabus

Module-I: Post Harvest / Pre Processing of Fruits & Vegetables

Fruit and vegetable production, classification, structure and composition, Importance and scope of pre harvest and postharvest management of fruits and vegetables in Indian economy, Pre-harvest factors affecting postharvest quality, post-harvest losses, Maturity indices and standards for selected fruits and vegetables, instrumental methods of maturity determination, standards and

specifications for fresh fruits and vegetable, Assessment of fruit quality, Advances in non-destructive quality measurement of fruits and vegetables.

Module-II: Post Harvest Changes in Fruits & Vegetables and their Primary Processing Operations

Post-harvest physiological and biochemical changes in fruits and vegetables, ripening of climacteric and non-climacteric fruits, changes during ripening, role of ethylene in fruit ripening, ripening chambers, Field heat of fruits and vegetables and primary processing operations post-harvest treatments, Advances in pre-cooling, equipment commodity pretreatments-chemicals, types of coating, pre-packaging, irradiation, blanching, peeling and other pre-processing operations, transportation and storage operations, Mechanism and advances in CA and MA, hypobaric storage, cold storage design, Zero energy cool chamber.

Module-III: Harvesting Tools and Post-Harvest Handling Operations

Advanced harvesting tools and their design aspects, advances in Post-harvest handling operations, Cleaning, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance, Sorting and grading: Sorting, grading, methods of grading, Size grading, color grading, specific gravity grading, screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance, Separation: Magnetic separator, de stoners, electrostatic separators, pneumatic separators.

Module-IV: Post Harvest Diseases & Disorders and their Remedies

Post-harvest disorders chilling injury and diseases, Biological, Physical and Chemical control of post-harvest diseases, Advances in drying and packaging of fruits and vegetables, Cushioning materials used in packaging of fresh fruits, Minimal processing.

Module-V: Post Harvest Handling of Grains

Crop drying principles and methods, Grain storage: principle and structures, Design of storage bins, Storage quality attributes of stored produce, Causes of wastes and pretreatments for minimizing losses during storage.

Reference Books and Suggested Readings:

Title	Author
Handbook of Fruit Science and Technology, Production	D.K. Salunkhe and S.S. Kadam
Post-Harvest Technology of Fruits and Vegetables	A.K. Thompson
Poultry Meat and Egg Production, CBS Publications, New Delhi, 1997	R. O. Carmen and J. M. George
Fish and Fish Products: Agrobios, Bikaner, 1999.	A. L. Winton and K. Barberwinton

NFT-509: FOOD INDUSTRY WASTE MANAGEMENT

L	T	P	C
3	1	0	4

Course objectives: The objectives of this course are to impart:

- Knowledge of standards and acts for protecting the environment during food processing
- Knowledge of by-products obtained during food processing and their utilization
- To understand the management of wastewater during processing of food

Course outcomes: On the successful completion of the course the students will be able to:

CO1	Understand and gain knowledge about standard environment (Protection) act of food processing wastes	Understanding
CO2	Gain knowledge about by-products obtained from different food processing industries and apply the knowledge for their utilization	Applying
CO3	Understand the properties of different food industry wastes	Understanding
CO4	Understand the concept of biological oxidation and advanced aeration devices systems	Understanding
CO5	Understand and able to apply the technology for the waste water management of food industries	Applying

Syllabus

Module-I: Standards and Acts

Food industry wastes, Food waste treatment, ISO 14001 standards, Standards for emission or discharge of environmental pollutants from food processing Industries as per Environment (Protection) Act, 1986. Elements of importance in the efficient management of food processing wastes

Module-II: By Products and their Utilization

Characterization and utilization of by-products from cereal, pulses, oilseeds, fruits and vegetables, plantation products, fermented foods, milk, fish, meat, egg and poultry processing industries.

Module-III: Characterization of Food Industry Effluents

Physical and chemical parameters, Oxygen demands and their inter relationship, Residues (solids), Fats, Oils and grease, Forms of Nitrogen, Sulphur and Phosphorus, Anions and cations, Surfactants, Colour, Odour, Taste, Toxicity, Unit concept of treatment of food industry

effluent, Screening, Sedimentation floatation as pre and primary reactants.

Module-IV: Biological Oxidation

Objectives, Organisms, Reactions, Oxygen requirements, Aeration devices Systems: Lagoons, Activated sludge process, Oxidation ditches, Rotating biological contactors and their Variations and advanced modifications.

Module-V: Advanced Waste Water Management

Advanced waste water management systems: Physical separations- Micro-strainers, Filters, Ultra filtration and reverse osmosis, Physico-chemical separations: activated carbon adsorption, Ion-exchange electro-dialysis and magnetic separation, Chemical oxidations and treatment: Coagulation and flocculation, Disinfection, handling and disposal of sludge.

Reference Books and Suggested Readings:

Title	Author
Waste Management for the Food Industries, Academic Press, 2008	I.S. Arvanitoyannis
Environmental Biotechnology: Industrial Pollution Management, (III ed.), Himalaya Publishing House, New Delhi, 2010	S.N. Jogdhand
Waste Treatment in the Food Processing Industry, CRC press, Taylor and Francis Group, 2006	L.K. Wang, Y.T. Hung and C. Yapijakis
Environmental Bioremediation Technologies, Springer Verlag Publishers, 2007	N. Singh, Shree and T.D. Rudra

NFT-511: PROCESSING & PRESERVATION OF FOODS

L	T	P	C
3	1	0	4

Course objective: The objective of this course is to impart

- Knowledge of finding the causes of quality deterioration and spoilage
- Knowledge of processing and preservation methods to enhance the quality and shelf life of food products.
- Knowledge of natural preservation and various preservatives for food

Course outcomes: On the successful completion of the course the student will be able to

CO1	Understand fundamental principles of food preservation methods and apply this knowledge to select preservation techniques for food products	Applying
CO2	Understand and apply low temperature processing of foods	Applying
CO3	Understand the principle of thermal processing and applying high temperature processing in food industry	Applying
CO4	Analyze the effect of water activity, drying and dehydration on quality of foods	Analyzing
CO5	Understand the impact of various preservatives on safety and quality parameters of food products	Understanding

Syllabus

Module-I: Introduction

Scope and importance of food processing- Properties of food- Physical, thermal, mechanical, sensory. Characteristics of tissues and non-tissues foods, Degree of perishability of unmodified foods, Causes of quality deterioration and spoilage of perishable foods, intermediate moisture foods, wastage of foods.

Module-II: Low Temperature Processing

Chilling temperatures: Consideration relating to storage of foods at chilling temperatures, Applications and procedures, Controlled and Modified atmosphere storage of foods, Post storage handling of foods. Freezing temperatures: Freezing process, Slow and fast freezing of foods and its consequence, other occurrences associated with freezing of foods. Technological aspects of

pre freezing, Actual freezing, Frozen storage and thawing of foods.

Module-III: High Temperature Processing

Basic concepts in thermal destruction of microorganisms D, Z, F values, Heat resistance and thermophilic microorganisms. Cooking, Blanching, Pasteurization and Sterilization of foods. Assessing adequacy of thermal processing of foods, General process of canning of foods, Spoilage in canned foods.

Module – IV: Drying and Dehydration

Sun drying of various foods, water activity and its effect on the keeping quality, sorption, isotherms and their use. Characteristics of food substances related to their dehydration behavior, drying phenomenon, factors affecting rate of drying, methods of drying of various food products, type of driers and their suitability for different foods; intermediate moisture foods.

Module – V: Preservation through Non-Thermal Techniques

Preservation of foods by Irradiation. Preservation of foods by use of sugar, salt, chemicals and antibiotics and by smoking. Natural preservation, Concentration: Application in food industry processes and equipment for manufacture of various concentrated foods and their keeping quality. Fermentation: Applications in preservation of food; pickling; curing etc, hurdle technology.

Reference Books And Suggested Readings:

Title	Author
Food Processing and Preservation	B. Sivasankar
Food Processing Technology : Principles and Practice	P.J Fellows
Food Processing Technology : Principles and Practice	M.Shafeiur Rahman
Food Processing and Preservation	Khetarpaul N

NFT-502: ADVANCES IN FOOD TECHNOLOGY-II

L	T	P	C
3	0	2	4

Course objectives: The objectives of this course are to impart:

- Knowledge of milk composition and advance technology for milk and its product processing.
- Knowledge of by-products production during milk processing and dairy plant sanitation.
- Knowledge about the advance processing of meat, marine, poultry and eggs.

Course outcomes: On the successful completion of the course the students will be able to:

CO1	Understand and describe the composition of milk and apply the knowledge of advance processing technology in milk processing	Analyzing
CO2	Apply the concept of advance methods in processing of different dairy products	Applying
CO3	Understand the by-product production during milk processing and concept of sanitation of dairy plant.	Understanding
CO4	Understand and analyze the concept of advance methods involved in meat and marine products processing	Analyzing
CO5	Understand and analyze the concept of advance methods involved in poultry and egg processing	Analyzing

Syllabus

Module-I: Advance Technology of Milk

Industry in India: present status and scope, Advances in processing of milk & milk products, FSSAI standards and legislations for market milk, Liquid milk processing, Technology of Ohmic Heating for Pasteurization of Milk, Advances in Microwave-Assisted Processing of Milk, Recent trends in milk procurement strategies and operation, Plate-form test and segregation of sweet and sour milk, Modern processing of fluid milk and distribution network.

Module-II: Advance Technology of Dairy Products

Technology of fat rich dairy products such as Cream, Butter and Ice-cream: Definition, classification, composition and technological aspects of preparation. Advancement in the Ghee Making Process, Technological Interventions in Kulfi Production, Classification of Dried Milk Products.

Module-III: Dairy Industry By-Products and Sanitation

By-products: Introduction, definition, composition, Importance and food applications, whey protein concentrates & isolates, Dairy plant sanitation: hygiene in dairy industry, different types of cleansing/sanitizing agents and their applications, cleaning systems in dairy industry.

Module-IV: Advances in Technology of Meat and Marine Products

Recent trends in processing of meat and meat Products in India, Chemical composition and microscopic structure of meat, Pre-mortem and post mortem changes influencing the quality of meat, Modern slaughter house management and by-product utilization.

Commercially important marine products from India, Product export and its sustenance, Processing operations, Basic biochemistry, Preservation of postharvest fish freshness, Transportation in refrigerated vehicles, Deodorization of transport systems, Design of refrigerated and insulated trucks, Grading and preservation of shell fish, pickling and preparation of fish protein concentrate, fish oil and other byproducts.

Module-V: Recent Advances in Poultry and Egg Products

Quality characteristics of poultry products, Lay-out and design of poultry processing plants, Plant sanitation, Poultry meat processing operations and equipment for de-feathering, bleeding, scalding etc., Poultry meat products, Refrigerated storage of poultry meat, by-products. Egg structure, structural abnormalities, functions of egg in food system, egg products, whole egg powder, egg yolk products, by-products, their packaging and storage, eating quality of eggs, Inspection and grading, preservation and safe handling.

Reference Books and Suggested Readings:

Title	Author
Novel Dairy Processing Technologies: Techniques, Management and Energy Conservation, Apple Academic Press, Distributed by CRC Press, a Taylor & Francis Group, USA, 2018	Megh R. Goyal, Anit Kumar and Anil K. Gupta
Dairy Chemistry and Biochemistry, Kluwer Academic, New York, 1998.	P.F. Fox and P.L.H. McSweeney

- Lawrie's Meat Science (6 Ed.), Woodhead Publications, Cambridge. R.A. Lawrie
- Meat and Meat Products: Technology, Chemistry and Microbiology, Chapman & Hill, London, 1995. H.V. Alan and P.S. Jane
- Poultry Meat and Egg Production, CBS Publications, New Delhi, 1997. R.O Carmen and J.M. George
- Fish and Fish Products, Agrobios, Bikaner, 1997. A.L. Winton and K.B. Winton

NFT-504: FOOD PROCESS ENGINEERING

L	T	P	C
3	1	0	4

Course objectives: The objective of this course is to impart

- Knowledge on engineering concepts of different food processing operations.
- Knowledge on equipments used in different food processing operations

Course Outcomes: On the successful completion of the course, students will be able to:

CO1	Understand the concepts of material and energy balances and apply to solve real problems	Applying
CO2	Analyse mass, momentum and energy balances during flow of fluids	Analyzing
CO3	Analyze heat transfer and calculate thermal process time during food processing	Analyzing
CO4	Understand refrigeration system and working principle of various evaporators used in food processing	Understanding
CO5	Understand the concept of different drying techniques, physical separation & extraction processes and its application in food processing	Applying

Syllabus

Module-I: Material and energy balance

Basic principles of material balance, Overall material balances, Concentration and Composition, Component Material Balances, Blending of Food Ingredients, Multistage Processes, Recycle and Bypass. The Steady-Flow Energy Equation, Heat Capacity, Latent Heat of Vaporization, Latent heat of fusion, Heat Balances, Overall energy balance

Module-II: Flow of fluids

Types of fluids, flow of fluids, rheology of fluids, mass, momentum and energy balances, Bernoulli Equation, fluid flow through pipes, flow of falling films, boundary layer, Reynolds number and flow regimes, friction losses in pipes and pipe fittings, flow of non-newtonian fluids.

Module-III: Thermal Processing of Foods

Mechanisms of Heat Transfer, Concept of Resistance to Heat Transfer, Overall Heat Transfer Coefficient, Heat Transfer in Heat Exchangers, Logarithmic Mean Temperature Difference, Concept of F value, z value, Q10 value, Thermal Process Calculations for Canned Foods, kinetics of chemical and biochemical reaction in foods

Module-IV: Refrigeration and Evaporation

Mechanical Refrigeration System, Heat pump, Refrigeration Cycle, Compressor, Condenser expansion device and Evaporator, Refrigeration Load, **Evaporators**: Single effect, multiple effect and other Evaporators

Module-V: Dehydration and Physical separation process

Principles of drying and dehydration, rates of drying: constant and falling rate periods during convective drying, freeze drying and spray drying; calculations of freeze drying and spray drying times. **Separation**: Centrifugation, separation, homogenizers, Micro filtration, ultra-filtration, reverse osmosis and electro dialysis. **Extraction**: Types of extractors, Leaching and Super critical fluid extraction.

Reference Books and Suggested Readings:

Title	Author
Fundamentals of Engineering Heat and mass transfer	R.C. Sachdeva
Fundamentals of Food Process Engineering	R.T. Toledo
Food Engineering Operations	Brennan, J.G. and J.R. Cowell
Food Process Engineering	Heldman, D.R. and R.P.Singh
Fundamentals of Food Process Engg.	Charm S.E
Elements of Food Engg	Harper J.C

NFT-506: FOOD SAFETY & QUALITY ASSURANCE

L	T	P	C
3	1	0	4

Course Objective: The objective of the course is to impart

- Knowledge to students on food hazards, contamination, food quality control and evaluation.
- Knowledge in national and international food standards along with application of ISO and FSMS in food processing industries
- Knowledge in quality management system and quality control in exporting and importing of food material

Course Outcomes: On the successful completion of the course the student will be able to

CO1	understand and analyze the different food hazards and contaminants	Understanding
CO2	Understand total quality management, and differentiate quality control and quality assurance	Understanding
CO3	Assess the quality of food	Evaluating
CO4	Discuss the emergence of FSSAI and various international food laws and regulations	Analyzing
CO5	Understand the importance of quality control measures in international food market	Understanding

Syllabus

Module-I: Food safety

Food safety - General principles of food safety. Characterization of food Hazards - physical, chemical and biological. Food spoilage and food borne infection hazards-sources of food spoilage and microorganisms- microbial problems in food safety-food toxicants and food poisoning –prevention. Cross contamination, Limits for pesticide and metal contamination of food. Adulteration, Food additives- types- usage, permissible limits, concept of safe food.

Module-II: Quality control and assurance

Objectives, Importance and Functions of Quality Control and Quality assurance, Quality control specifications, training of food technologists for quality control, implementation of standards and specifications, principles of quality control – raw material control, process control, finished product inspection, process control, quality problems and quality improvement techniques-mechanization, future of quality.

Module-III: Food Quality Evaluation

Classification of Quality Attributes and their role in food Quality. Quality Assessment of Food materials-Fruits, vegetables, cereals, legumes, dairy products, meat, poultry, egg and processed food. Sensory Evaluation of Food Quality. Regulating methods for food analysis, case studies.

Module-IV: International and National Food Laws and Standards

Food safety standard act of india- 2006, Bureau of Indian Standards (BIS), Agricultural Grading and Marketing (AGMARK), The. Food and Drug Administration Act (FDA), International Organization for Standards (ISO), Requirement and procedure for ISO certification and its implication, Generally recognized as safe (GRAS), European Council (EU), Codex Alimentarius Commission (CAC), Total Quality Management (TQM), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), and Good Hygienic Practices (GHP), GMP, Hazard Analysis Critical Control Point (HACCP).

Module-V: Quality Control Measures in Industries and Market

Quality control system in storage, Quality control aspects in food industries, Importance of quality control in marketing of Food products - domestic and export markets. International standards for export and quarantine requirements for export of Agricultural and Horticultural produce.

Reference Books and Suggested Readings:

Title	Author
Food Quality Assurance: Principles and Practices	Inteaz Alli
Rheology and Texture in Food Quality	J.M.DeMan
Food Analysis : Theory and practice	Y.Pomeranz
Principles of Sensory Analysis of Food	M.A. Amerine

NFT-508 NUTRACEUTIAL AND FUNCTIONAL FOODS

L	T	P	C
3	1	0	4

Course objectives: The objective of the course is to impart

- Knowledge of functional foods and nutraceuticals and their significance on health
- Knowledge about the role of nutraceuticals in disease prevention
- Knowledge development of functional food for a specific disease

Course Outcomes: On the successful completion of the course, students will be able to:

CO1	Understand the technological aspects of functional foods and nutraceuticals	Understanding
CO2	Understand and select suitable functional food and nutraceuticals for common diseases	Understanding
CO3	Understand the chemistry and physiological effects of bioactive compounds on human health	Understanding
CO4	Understand the role of selected Functional foods in health promotion	Analyzing
CO5	Discuss the regulations with respect to functional foods and Nutraceuticals	Analyzing
CO6	Develop a functional food for a given metabolic disorder	Creating

Syllabus

Module-I: Technological Aspects of Nutraceuticals and functional Foods

Defining nutraceuticals and functional foods, nature, type and scope. Nutraceuticals and functional foods applications and their health benefits, classification based on chemical and biochemical nature with suitable and relevant descriptions.

Module-II: Nutraceuticals for specific diseases

Food recommended and restricted in metabolic disorders and disturbances, gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases, allergies, infant and baby foods,

adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods

Module-III: Functional role of bio-active compounds

Antioxidants, phytochemicals, isoflavones, lycopenes, their role in Nutraceuticals and functional foods, dietary fibers and complex carbohydrates as functional food ingredients. Health benefits/ mode of action of PUFA/ gamma linolenic acids, Proteins as a functional food ingredients, probiotic foods and their functional role, minerals and other minor food constituents as reported in literature.

Module-IV: Role of Specific Food Products as a Functional Food

Herbs as functional foods, health promoting activity of common herbs. Cereal products as functional foods- Oats, Wheat bran, rice bran etc. Functional vegetable products, oil seeds and sea foods. Coffee, tea and other beverages as functional foods/ drinks and their protective effects

Module-V: Legal Aspects of Nutraceuticals & Functional foods

Effects of processing and storage, interaction of various environmental factors on the potentials of such foods. Marketing and regulatory issues of Nutraceuticals and functional foods and. Recent developments and advances in the area of Nutraceuticals and functional foods.

Reference Books And Suggested Readings:

Title	Author
Handbook of Nutraceutical and Functional Foods	Wildman REC
Angi-angiogenic Functional and Medicinal Foods	Losso JN
Handbook of Nutraceuticals	Pathak YV
Innovations in Healthy and Functional Foods	Ghosh D et al
Nutrition and Dietetics	S. A. Joshi

NFT-510: CRYOGENIC SYSTEMS IN FOOD PROCESSING

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to impart

- Basic knowledge of cryogenics and its application in food processing.
- Knowledge of methods and instruments used for cryogenic processing.
- Knowledge of International and national codes and standards of safe handling of cryogenic fluids.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the engineering properties of cryogenic fluids and their conductivity	Understanding
CO2	Understand the principle of refrigeration and liquefaction	Understanding
CO3	Understand & apply the knowledge of storage and transfer systems designing	Applying
CO4	Understand the principle and working of cryogenic instrumentation	Understanding
CO5	Understand and apply the international and national standards related to handling of cryogenic fluids	Applying

Syllabus

Module I: Introduction to cryogenics

Applications involving Cryogenic Engineering, Properties of Cryogenic Fluids: Oxygen, Nitrogen, Air, Argon, Neon, Fluorine, Hydrogen, Helium. Properties of Solids: Mechanical Properties, Thermal Properties, Electrical Properties, Superconductivity.

Module II: Refrigeration and Liquefaction

Refrigeration and liquefaction principles, Joule-Thomson expansion, isentropic expansion, Cascade processes, Ortho-Parahydrogen conversion, cold-Gas refrigerators, miniature refrigerators, Ultra-Low-Temperature refrigerators, Thermodynamic analyses of system.

Module III: Storage and Transfer Systems

Basic storage vessels and design issues of small and large storage dewars. Structural design of Inner vessel and outer vessels, Design of suspension system, Insulation systems, Surface evaporation, thermal overfill, thermo-acoustic oscillation, eddy current heating, Cooling of storage vessels, cool down time estimation. Transfer systems, Industrial storage and transfer of cryogenics, Cool down of Storage and Transfer System.

Module IV: Cryogenic Instrumentation

Properties characterizing cryogenic Instrumentation, strain, displacement and position, Pressure, Flow, Liquid Level, Density, Temperature.

Module V: Safety Issues with Cryogenic Fluids

Cryogenic safety, General safety issues, cold damage, Asphyxiation, sudden thermal contraction and pressure build-up in cryogen systems, brittle failure, LNG safety, Properties – Flammability, auto ignition temperature, rapid phase transition, LNG storage tanks, Risk of LNG fires, Oxygen safety – General concept of ignition and combustion, ignition mechanisms of different types, Effect of operating parameters, Selection of materials for oxygen use, Design of systems with oxygen rich environment, International and national codes and standards of safe handling of cryogenic fluids.

Reference Books and Suggested Readings:

Title

Author

Cryogenic Process Engineering

Klaus D. Timmerhaus

Cryogenic Systems

by Randall F. Barron

NFT-512: ADVANCES IN FOOD PACKAGING TECHNOLOGIES

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to impart

- Knowledge about properties of food packaging material and its effect on enhancing shelf life and quality of food.
- To know the different types of packaging machines and their fitment in the process line.
- To know the recent advances in food packaging.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the fundamentals of packaging and properties of packaging materials	Understanding
CO2	Analyze the properties of packaging materials	Analyzing
CO3	Understand the economics of packaging and apply knowledge for designing packaging various foods	Applying
CO4	Understand the labeling of food packages as per legal requirements.	Understanding
CO5	Understand novel packaging of foods	Understanding

Syllabus

Module-I: Introduction of food packaging

Primary and secondary functions of a package. Product characteristics and protection required through packaging. Packaging materials: Physico-mechanical, optical, thermal and barrier properties

Module-II: Analysis of packaging materials

Development of protective packaging, shelf life studies using packaging materials, methods of shelf life estimation, packaging materials properties and identification, paper and paper boards

production, storage and recycling of packaging materials, standards & regulation and equipment analysis of various existing packaging system

Module-III: Packaging economics

Evaluation of packaging economics, packaging operations cost consideration and disposability. Hazards in distribution & design of packages for various foods.

Module-IV: Package labeling and designing

Label, types of label, importance of nutritional labeling package design consideration, cushioning materials and their properties Testing and Identification of packaging materials

Module-V: Novel techniques in packaging

Technologies for novel packaging materials for active packaging, biodegradable packaging, edible packaging and nano packaging materials. Tailoring of packaging materials. Thermal processing, aseptic packaging lines and retortable pouches. Microwave-ovenable packaging materials, Modified atmosphere packaging and RFID indicator, Consumers and novel packaging. Oxygen, ethylene Carbon dioxide and other scavengers: Scavenging technology, and its applications.

Reference Books and Suggested Readings

Title	Author(s)
Handbook of Food Packaging Technology	Frank Albert Paine, Heather Y. Paine
A Handbook of Food Packaging	Painy FA.
Principles of Food Packaging	Sacharow S & Griffin RC
Food Packaging	Kadoya T
Food Packaging Materials	Mahadeviah M & Gowramma RV.
Developments in Food Packaging	Palling SJ.

NFT-601: FROZEN FOODS AND COLD CHAIN MANAGEMENT

L	T	P	C
3	1	0	4

Course objectives: The objective of this course to impart

- Knowledge on concepts of freezing and Freezing process
- Knowledge about application of freezing and cryogenic systems in food processing
- Knowledge of cold chain management systems and storage for increasing shelf life of food

Course Outcomes: On the successful completion of the course, students will be able to:

CO1	Understand the concept of freezing process of food materials	Understanding
CO2	Understand and implement the concept of cold chain management system and application of cryogenic systems	Applying
CO3	Understand and analyze the effect of freezing on quality and safety aspects of frozen foods	Analyzing
CO4	Understand the principle of monitoring techniques required to maintain/check the shelf life of frozen foods	Understanding
CO5	Analyze packaging requirements for the frozen foods	Analyzing

Syllabus

Module-I: Fundamentals and innovation in freezing

Fundamentals of freezing: Glass transition in frozen foods, microbiology of frozen foods, thermo-physical properties of frozen foods, Freezing load and freezing time calculations, Innovation in freezing process.

Module-II: Cold chain management system

Facilities for the cold chain: freezing methods and equipment, cold store design and maintenance, transportation of frozen foods, retail display equipment and management, household refrigerators and freezers, monitoring and control of the cold chain. Stages and points of control in cold storages and structures.

Module-III: Quality and safety of frozen foods

Quality and Safety of Frozen Foods: Quality and Safety of frozen meat and meat product, Quality and safety of frozen poultry and poultry products, Safety and quality of fish, Shellfish and related products, Quality and safety of frozen vegetables, fruits, dairy products, ready meals, bakery products, Eggs and eggs products.

Module-IV: Monitoring and measuring techniques

Monitoring and measuring techniques for quality and safety: Chemical measurements, sensory analysis of frozen foods, Food borne illnesses and detection of pathogenic microorganisms, shelf life prediction of frozen foods. Time indicators (TTI), Time, Temperature, Correlation, The kinetic approach, Effective temperature Transportation regulations

Module-V: Packaging of frozen foods

Packaging of frozen foods: Introduction to frozen food packaging, plastic packaging of frozen foods, paper and card packaging of frozen foods, Packaging of frozen foods with other materials, Packaging machinery.

Reference Books and Suggested Readings:

Title	Author(s)
Food Processing Technolgy – Principles and applications	Fellows, P.J
The Freezing Preservation of Foods	Tressler D.K.& EversC.F
Cold and Chilled Storage Technology	Clive DellinoD.J
Frozen Food Technology	Ed.Mallet C.P

NFT-603: NOVEL TECHNIQUES IN FOOD PROCESSING & PRESERVATION

L	T	P	C
3	1	0	4

Course Objective: The objective of the course is to impart

- Knowledge about working principles of various innovative techniques in food processing
- Knowledge about application of novel techniques to improve quality and yield of production.

Course outcomes: On the successful completion of the course the student will be able to

CO1	Discuss about membrane technology and its application in food processing	Analyzing
CO2	Understand and apply High pressure processing and super critical fluid extraction in food processing	Applying
CO3	Understand and apply microwave and radio frequency wave technology in food processing	Applying
CO4	Explain about ohmic, IR heating, PEF, PLT & cold plasma and its application in food processing	Analyzing
CO5	Apply ultrasonicator and hurdle technology in food processing	Applying

Syllabus

Module-I: Advances in membrane technology

Membrane Technology, membrane processing technology of liquid foods, different membrane modules, types of membrane 1G to 3G. Factors affecting flux and related equations, application of membrane in food processing & preservation.

Module-II: SCE process and HPP

Theoretical concept of super critical extraction process, equipment used and its application in food processing & preservation. Theoretical concept of high pressure technology equipment used and its application in food processing & preservation.

Module-III: Application of microwave and RF technology

Theoretical concept of Microwave and radio frequency technology equipment used and its application in food processing & preservation.

Module-IV: Ohmic, IR heating and cold plasma processing

Concept and technology of ohmic heating, IR heating, inductive heating and X-rays in food processing and preservation, Pulse Electric field, Pulse Light Technology, concept and technology of cold plasma, application limitation.

Module-V: Ultrasonicator and Hurdle Technology

Theoretical concept of ultrasound/sonication technology, equipment used and its application in food processing & preservation. Hurdle technology its concept and application in food preservation.

Reference Books and Suggested Readings:

Title	Author
Emerging Technologies for Food Processing.	Da-Wen Sun
Novel Food Processing Technologies	M. P. Cano, M. S. Tapia, and G. V.
Innovation in Food Engineering: New Techniques and Products,	Maria Laura Passos, Claudio P. Ribeiro
Nonthermal Processing Technologies for Food	Howard Q. Zhang. et al., 2000
Non-thermal Food Engineering Operations	Enrique Ortega-Rivas
Food Processing Technologies: Impact on Product Attributes	Amit K. Jaiswal

NFT-605: COMPUTER APPLICATION IN FOOD PROCESSING

L	T	P	C
3	1	0	4

Course objectives: The objective of the course is to impart

- Knowledge about the concept of modeling & simulation and different numerical methods to solve the Partial Differential Equations (PDEs) related to food processes
- Knowledge about the use of softwares to apply the numerical methods to solve PDEs

Course outcomes: On the successful completion of the course, students will be able to:

CO1	Understand and differentiate the concepts of modeling and simulation	Understanding
CO2	Understand and select suitable numerical method to solve the given PDE	Understanding
CO3	Execute a MATLAB/Scilab programme to solve a PDE	Applying
CO4	Understand and apply the concept of optimization methods to food processes	Applying
CO5	To model different food processing operations	Creating

Syllabus

Module-I: Modeling and Simulation

Fundamentals of modeling and simulation; definition of basic terms like system, entity attribute, activity, state of system, system environment; categories of system, stochastic activities; Different steps involved in modeling and simulation, Types of models, advantages of modeling and simulation, disadvantages of modeling; Monte Carlo Method of random simulation, Application areas of simulation.

Module-II: Algorithms for Numerical methods

Numerical methods for solving transcendental model equations; iterative convergence method, derivation and algorithms of bisectional method or intermediate value theorem; false position or Regula Falsi method; Newton Raphson method, Iterative or method of successive approximation; Solution of ordinary differential equation model: Picard, Taylor's series method.

Euler's method, Modified Euler's method, First order, third and fourth order Runge Kutta method.

Module-III: Partial differential equations models

Differential Laplace, parabolic and hyperbolic equation, Finite difference method, graphical method, Bender-Schmidt method Sci-lab/ MATLAB based solutions to partial differential equations.

Module-IV: Optimization systems

Introduction, optimization theory, optimization methods: Graphical and numerical methods of optimization, unconstrained optimization, constrained optimization, Programming optimization, experimental optimization, Data analysis in Excel, Response surface methodology (RSM). Artificial neural network, Machine Learning, Finite Element Method and Fuzzy logic: Concepts and applications of Fuzzy logic and ANN in food processing.

Module-V: Modeling and Simulation of food engineering operations

Thermal processing, convection dehydration, osmotic dehydration, spray drying, Freeze drying, Freezing Process; deep fat frying; extrusion process; filtration processes; membrane separation; distillation and extraction processes, Image analysis.

Reference Books and Suggested Readings:

Title	Author
Computerized Control Systems in the Food Industry	Gauri S. Mittal
Response surface methodology	R. H. Myers
Computer aided techniques in Food Technology	Israel Saguy
Response surfaces design and analysis	AI. Khuri
Design of Experiments	Douglas C. Montgomery

OFT-601: ADVANCES IN FOOD PROCESSING & PRESERVATION

L	T	P	C
3	0	0	3

Course objective: The objective of this course is to impart

- Knowledge of finding the causes of quality deterioration and spoilage
- Knowledge of processing and preservation methods to enhance the quality and shelf life of food products.
- Knowledge of natural preservation and various preservatives for food

Course outcomes: On the successful completion of the course the student will be able to

CO1	Understand type of foods based on perishability, Causes of spoilage and fundamental principles of food preservation	Understanding
CO2	Understand and apply low temperature processing of foods	Applying
CO3	Understand the principle of thermal processing and applying high temperature processing in food industry	Understanding, Applying
CO4	Analyze the effect of water activity, drying and dehydration on quality of foods	Analyzing
CO5	Applying non thermal and novel techniques in food processing and preservation	Applying

Syllabus**Module-I: Introduction**

Scope and importance of food processing- Properties of food- Physical, thermal, mechanical, sensory. Characteristics of tissues and non-tissues foods, Degree of perishability of unmodified foods, Causes of quality deterioration and spoilage of perishable foods, intermediate moisture foods, wastage of foods.

Module-II: Low Temperature Processing

Chilling temperatures: Consideration relating to storage of foods at chilling temperatures, Applications and procedures, Controlled and Modified atmosphere storage of foods, Post storage handling of foods. Freezing temperatures: Freezing process, Slow and fast freezing of foods and its consequence, other occurrences associated with freezing of foods. Technological aspects of pre freezing, Actual freezing, Frozen storage and thawing of foods.

Module-III: High Temperature Processing

Basic concepts in thermal destruction of microorganisms D, Z, F values, Heat resistance and thermophilic microorganisms. Cooking, Blanching, Pasteurization and Sterilization of foods. Assessing adequacy of thermal processing of foods, General process of canning of foods, Spoilage in canned foods.

Module – IV: Drying and Dehydration

Sun drying of various foods, water activity and its effect on the keeping quality, sorption, isotherms and their use. Characteristics of food substances related to their dehydration behavior, drying phenomenon, factors affecting rate of drying, methods of drying of various food products, type of driers and their suitability for different foods; intermediate moisture foods.

Module – V: Preservation through Non-Thermal and Novel Techniques

Preservation of foods by Irradiation. Preservation of foods by use of sugar, salt, chemicals and antibiotics, High Pressure Processing, ohmic heating, IR heating, Application of microwave and Radio frequency in food industries, Ultrasonication technology and cold plasma technology in food processing., Fermentation: Applications in preservation of food; pickling; curing etc, hurdle technology.

Reference Books And Suggested Readings:

Title	Author
Food Processing and Preservation	B. Sivasankar
Food Processing Technology : Principles and Practice	P.J Fellows
Food Processing Technology : Principles and Practice	M.Shafeiur Rahman
Food Processing and Preservation	Khetarpaul N